

WHAT IS CLAIMED IS:

- 1 1. A method of forming an oxide layer, the method comprising:  
2 providing a workpiece;  
3 providing a fluid, the fluid having a temperature and a pressure;  
4 increasing the temperature and the pressure of the fluid until the fluid reaches a  
5 supercritical or near-supercritical state;  
6 providing at least one oxidizing agent;  
7 combining the supercritical or near-supercritical state fluid with the at least one oxidizing  
8 agent to form a supercritical or near-supercritical state mixture; and  
9 applying the supercritical or near-supercritical state mixture on the workpiece to form an  
10 oxide layer on the workpiece.
- 1 2. The method according to Claim 1, wherein the workpiece includes surface  
2 contaminations on a surface thereof, wherein the surface contaminations are removed  
3 simultaneously with the forming of the oxide layer.
- 1 3. The method according to Claim 1, wherein the fluid comprises H<sub>2</sub>O or CO<sub>2</sub>.
- 1 4. The method according to Claim 1, wherein increasing the temperature of the fluid  
2 comprises increasing the temperature of the fluid to a temperature of about 300 °C to about 750  
3 °C.
- 1 5. The method according to Claim 1, wherein increasing the pressure of the fluid comprises  
2 increasing the pressure to a pressure of about 176 bar to about 440 bar.

1 6. The method according to Claim 1, wherein applying the supercritical or near-supercritical  
2 state mixture on the workpiece comprises a flow rate of about 0.1 liter per minute to about 25  
3 liters per minute.

1 7. The method according to Claim 1, wherein providing the at least one oxidizing agent  
2 comprises providing O<sub>2</sub>, O<sub>3</sub>, H<sub>2</sub>O<sub>2</sub>, NO, N<sub>2</sub>O, NO<sub>2</sub>, N<sub>2</sub>O<sub>2</sub>, organic alcohol, organic acid, organic  
3 aldehyde or combinations thereof.

1 8. The method according to Claim 1, wherein providing the at least one oxidizing agent  
2 comprises providing NO, N<sub>2</sub>O, NO<sub>2</sub>, N<sub>2</sub>O<sub>2</sub>, or combinations thereof.

1 9. The method according to Claim 8, wherein forming the oxide layer comprises forming  
2 nitrogen doped oxide.

1 10. The method according to Claim 1, wherein the workpiece comprises a semiconductor  
2 material selected from the group consisting of Si, Ge, SiGe, GaAs, InAs, InP, Si/Si, Si/SiGe, and  
3 silicon-on-insulators.

1 11. The method according to Claim 1, wherein the workpiece includes a material layer  
2 formed thereon, wherein forming the oxide layer comprises forming the oxide layer over the  
3 material layer.

1 12. The method according to Claim 11, wherein forming the oxide layer comprises forming a  
2 capacitor dielectric layer over the material layer.

1 13. The method according to Claim 12, wherein the material layer comprises a bottom  
2 capacitor plate of a metal-insulator-metal (MIM) capacitor, further comprising forming a top  
3 capacitor plate over the capacitor dielectric layer.

1 14. The method according to Claim 1, wherein forming the oxide layer comprises forming a  
2 gate oxide layer.

1 15. The method according to Claim 14, further comprising:  
2 depositing a gate contact layer over the gate oxide layer;  
3 patterning the gate contact layer and gate oxide layer; and  
4 doping portions of the workpiece to form source and drain regions in the workpiece,  
5 forming a transistor device comprising the source and drain regions, gate oxide layer and gate  
6 contact layer.

1 16. The method according to Claim 1, wherein forming the oxide layer comprises forming  
2 the oxide layer at a rate of about 5 Angstroms per minute or greater.

1 17. The method according to Claim 1, wherein forming the oxide layer comprises forming  
2 about 400 to about 800 nm of material.

- 1 18. A method of forming an oxide layer, the method comprising the steps of:  
2 providing a workpiece; and  
3 exposing the workpiece to a mixture of a supercritical state fluid or near-supercritical  
4 state fluid and at least one oxidizing agent, forming a layer of oxide on the workpiece.
- 1 19. The method according to Claim 18, wherein the supercritical state fluid or near-  
2 supercritical state fluid comprises H<sub>2</sub>O or CO<sub>2</sub>.
- 1 20. The method according to Claim 18, wherein the at least one oxidizing agent comprises  
2 O<sub>2</sub>, O<sub>3</sub>, H<sub>2</sub>O<sub>2</sub>, NO, N<sub>2</sub>O, NO<sub>2</sub>, N<sub>2</sub>O<sub>2</sub>, organic alcohol, organic acid, organic aldehyde or  
3 combinations thereof.
- 1 21. The method according to Claim 18, wherein the temperature of the supercritical state  
2 fluid or near-supercritical state fluid is about 300°C to about 750°C, and wherein the pressure of  
3 the supercritical state fluid or near-supercritical state fluid is about 176 bar to about 440 bar.
- 1 22. The method according to Claim 18, wherein exposing the workpiece to the mixture  
2 comprises applying the mixture on the workpiece at a flow rate of about 0.1 liter per minute to  
3 about 25 liters per minute.
- 1 23. The method according to Claim 18, wherein the oxidizing agent comprises N<sub>2</sub>O, NO<sub>2</sub>,  
2 N<sub>2</sub>O<sub>2</sub>, or combinations thereof, and wherein the layer of oxide comprises nitrogen doped oxide.
- 1 24. The method according to Claim 18, wherein the workpiece includes surface  
2 contaminations on a surface thereof, wherein the surface contaminations are removed  
3 simultaneously with the forming of the oxide layer.

1 25. The method according to Claim 18, wherein the workpiece includes a material layer  
2 formed thereon, wherein forming the layer of oxide comprises forming the layer of oxide on the  
3 material layer.

1 26. The method according to Claim 25, wherein forming the layer of oxide comprises  
2 forming a capacitor dielectric layer on the material layer.

1 27. The method according to Claim 26, wherein the material layer comprises a bottom  
2 capacitor plate of a metal-insulator-metal (MIM) capacitor, further comprising forming a top  
3 capacitor plate over the capacitor dielectric layer.

1 28. The method according to Claim 18, wherein forming the layer of oxide comprises  
2 forming a gate oxide layer.

1 29. The method according to Claim 28, further comprising:  
2 depositing a gate contact layer over the gate oxide layer;  
3 patterning the gate contact layer and gate oxide layer; and  
4 doping portions of the workpiece to form source and drain regions in the workpiece,  
5 forming a transistor device comprising the source and drain regions, gate oxide layer, and gate  
6 contact layer.

1 30. The method according to Claim 18, wherein forming the layer of oxide comprises  
2 forming the layer of oxide at a rate of about 5 Angstroms per minute or greater.

1 31. The method according to Claim 18, wherein forming the layer of oxide comprises  
2 forming about 400 to about 800 nm of material.

- 1 32. A method of forming an oxide layer, the method comprising:  
2 providing a workpiece, the workpiece having a surface;  
3 combining water in a supercritical state with an oxidizing agent; and  
4 exposing the workpiece to the combined supercritical water and oxidizing agent, forming  
5 an oxide layer on the surface of the workpiece.
- 1 33. The method according to Claim 32, wherein the oxidizing agent comprises O<sub>2</sub>, O<sub>3</sub>, H<sub>2</sub>O<sub>2</sub>,  
2 NO, N<sub>2</sub>O, NO<sub>2</sub>, N<sub>2</sub>O<sub>2</sub>, organic alcohol, organic acid, organic aldehyde or combinations thereof.
- 1 34. The method according to Claim 32, wherein the workpiece comprises Si, Ge, SiGe,  
2 GaAs, InAs, InP, Si/Si, Si/SiGe, or a silicon-on-insulator substrate.
- 1 35. The method according to Claim 32, wherein the workpiece surface includes a material  
2 layer formed thereon, wherein forming the oxide layer comprises forming the oxide layer on the  
3 material layer.